AMENDMENTS TO THE SPECIFICATION

- Please add a Cross-Reference to Related Application(s) section, which begins on page 1, line 2, as follows:

CROSS-REFERENCE TO RELATED APPLICATION(S)

This is a Divisional of co-pending application serial number 09/640,534 filed 8/17/2000, the entire disclosure of which is incorporated herein by reference.

- Please amend the paragraph which begins on page 1, line 4, in the Background of the Invention, as follows:

The invention relates to the fabrication of integrated circuit devices, and more particularly, to a method of creating a molded package structure for flip chips using ~~a one step~~ one-step ~~molding~~ mold compound injection process.

- Please amend the paragraph which begins on page 2, line 4, in the Background of the Invention, as follows:

Where circuit density keeps increasing and device feature size continues to be reduced, the effect of the interconnect metal within the package becomes relatively more important to the package performance. Factors that have a negative impact on circuit performance, such as line resistance, parasitic capacitance, RC-delay constants, crosstalk and contact resistance, have a considerable impact on the package design and its limitations. A significant power drop may for instance be introduced along the power and ground buses where the reduction of the interconnect metal does not match the reduction in the size of the device features. Low resistance metals (such as copper) are therefore finding wider application in the design of dense semiconductor packages.

- Please amend the paragraph which begins on page 3, line 25, in the Description of the Prior Art, as follows:

Fig. 1 shows a cross section of a typical flip chip package with underfill and a heatsink. The IC 10 enters the process as a separate unit with the contact points (balls 18) attached to the bottom of the chip 10. The IC 10 is placed in a cavity 22 that is formed by the spacers 14 between the heatsink 16 and the substrate 12. While the chip 10 is contained in cavity 22, the underfill 21 under the surface of the IC chip 10 is injected or ~~fills~~ filled by capillary action. The balls 20 connected to the lower surface of the substrate 12 make contact with the surrounding circuitry. It should be noted in Fig. 1 that the sides of the underfill 21 are sloping such that the physical contact between the underfill 21 and the substrate 12 is extended beyond the dimensions of the bottom surface of the chip 10. This is a normal phenomenon with liquid underfill, which enhances heat interchange between the substrate 12 and the IC chip 10.

- Please amend the paragraph which begins on page 4, line 11, in the Summary of the Invention, as follows:

A principle objective of the invention is to create underfill for flip-chip type Integrated Circuits (IC's) in one processing step by forcing ~~the epoxy~~ a mold compound to flow under the die rather than over the backside of the die.

- Please amend the paragraph which begins on page 4, line 14, in the Summary of the Invention, as follows:

Another objective of the invention is to relieve thermal and mechanical stress between the flip-chip die and the heatsink that is attached to the die by creating a uniform flat surface ~~that is equal in height to the thickness of the die~~ as an interface between the die and the heatsink. This uniform flat surface distributes the stress that is introduced by the attachment of the heatsink over a larger area, thereby reducing the stress to which the die is subjected (during heatsink attachment).

- Please amend the paragraph which begins on page 4, line 19, in the Background of the Invention, as follows:

In accordance with the objectives of the invention a new method is provided to insert the underfill for flip-chip semiconductor devices. An IC chip is provided with solder bumps. The flip-chip is entered into ~~a cavity~~ an enclosed space, the heatsink forms the top of the ~~cavity~~ enclosed space, the substrate forms the bottom of the ~~cavity~~ enclosed space. The ~~cavity~~ enclosed space is filled with a ~~molding compound~~ mold compound. This ~~molding compound~~ mold compound now surrounds the IC chip thereby including the area below the IC. The step of inserting the underfill as a separate processing step has thereby been eliminated.

- Please amend the paragraph which begins on page 5, line 4, in the Description of the Preferred Embodiments, as follows:

Referring now specifically to Fig. 2, there is shown a cross section of the process of providing a flip-chip with an underfill in one processing step. The flip-chip 30 is mounted inside the cavity 32 and between the heatsink 16 and the substrate 12 as shown. ~~Molding~~ A mold compound 34 is now injected into the cavity 32 thereby filling the areas around the flip-chip 30, including the areas underneath the flip chip. The flip-chip is in this manner encased in one processing step whereby the encasing makes contact with the heatsink 16 and the substrate 12 while also providing the underfill. The flip-chip contact balls 18 and the substrate contact balls 20 remain in place as under Prior Art processing steps and perform the same circuit functions as highlighted above.

- Please amend the paragraph which begins on page 5, line 13, in the Description of the Preferred Embodiments, as follows:

The total package that has been created in this manner contains the IC chip 30 with its contact balls 18, a ~~molding~~ mold compound 34 that surrounds the IC chip 30 while providing

the underfill for the IC chip 30, a heatsink 16 and a substrate 12 with its contact balls 20. Substrate 12 is provided with a network of interconnect lines that interconnects the substrate upper surface contact points with the substrate lower surface contact points, this network to be contained in one or more planes within the substrate. Cavity 32 is created by creating four planer spacers that separate the heatsink from the substrate by a measurable amount, this amount to be selected such that contact points of the IC device make contact with the substrate upper surface contact points while a upper surface of the IC device make contact with the heatsink.

- Please amend the paragraph which begins on page 5, line 16, in the Description of the Preferred Embodiments, as follows:

From the cross section that is shown in Fig. 2 it is clear that:

- by forming the cavity 32 into which the ~~epoxy~~ mold compound 34 is injected, the upper surface of the flip chip 30 is firmly pressed against the surface of the heatsink 16, forcing in the ~~epoxy~~ mold compound 34 that is injected into the ~~cavity 34~~ cavity 32 under ~~the flip~~ the flip chip 30 and between the contact balls 18, and
- the surface of heatsink 16 (which is essentially parallel with the upper surface of the flip chip) provides firm and uniform support for the flip chip 30, eliminating localized areas of pressure on the flip chip 30 and eliminating the potential for damage to the flip chip 30 at the time that the flip chip 30 is attached to the ~~heatsink 16~~ heatsink 16.

- Please amend the paragraph which begins on page 5, line 24, in the Description of the Preferred Embodiments, as follows:

Fig. 3 shows a method that can be used to implement the encasing of the flip-chip in accordance with the invention. The heatsink 16 can be attached (by adhesion) to a flexible tape 40. The flexible tape 40 can be put into motion to move or position the flip-chip 36 to a processing station for the mold injection by means of the rotary motors 42. The flip-chip 36 is placed on top of the heatsink 16 with its contact points (balls) 18 facing upwards. The substrate 12 is placed on top of the contact points 18 such that the contact points (balls) 20 of

the substrate 12 also face in an upwards direction. When the package of heatsink 16, flip-chip 36 and substrate 12 ~~reach the~~ reaches the mold injection processing station, mold 38 is entered into the cavity 46 between the heatsink 16 and the substrate 12. The mold 38 will fill the complete cavity 46, encapsulating the flip-chip 36 including the area directly between the bottom of the flip-chip 36 and the top of the substrate 12 (the underfill). As a separate embodiment of the invention, the process as indicated can be performed without the use of a heatsink. This for applications and designs of flip-chips where a heatsink is not required. With the flip-chip traveling in direction 43, the mold 38 that has been injected into the cavity 46 can be treated and cured by UV exposure at station 41.

- Please amend the paragraph which begins on page 6, line 7, in the Description of the Preferred Embodiments, as follows:

The advantages that ~~applied~~ apply to the method shown in cross section in Fig. 2 equally apply to the method shown in cross section on Fig. 3, that is forcing the ~~epoxy~~ mold compound under the flip chip and having a uniform, stress free interface between the flip chip 36 and the heatsink 16.

- Please amend the paragraph which begins on page 6, line 10, in the Description of the Preferred Embodiments, as follows:

It is clear that, where Fig. 3 shows the creation of a package for one flip chip, this concept can readily be extended to include the creation of multiple chip packages in one step of mold injection. By extending the length of the cavity 46 such that a multiplicity of flip chips can be fitted inside that created cavity, packages for this multiplicity of flip chips can be created. This concept is further highlighted under the following Figs. ~~4 through~~ 4a through 4c.

- Please amend the paragraph which begins on page 6, line 17, in the Description of the Preferred Embodiments, as follows:

For the example shown in Fig. 4a, three flip chips (50, 52 and 54) have been mounted in the manner previously described under Fig. 3. A relatively large cavity 64 is in this manner formed between the heatsink 56 and the substrate 58. The arrangement of multiple chips can again be transported to a mold injection station by means of a flexible tape 60. When the cavity 64 has been aligned in the proper position (with respect to the ~~mold injection station~~ injection of mold compound 62), the mold compound 62 can be injected into cavity 64, surrounding all flip-chips that are contained within the cavity (here: 50, 52 and 54) with the mold compound 62. If the flip-chips travel in direction 66, the mold compound 62 that surrounds the flip-chip after injection can be treated and cured by UV exposure at station 68. Cavity 64 is a cavity for the second assembly 61, this cavity 64 to comprise planes that are bordered by the heatsink 56 and the IC substrate 58 and that additionally intersect the first surface of the heatsink 56 and the first surface of the IC substrate 58 under an angle, the cavity further 64 enclosing at least one Integrated Circuit device, the cavity 64 further having been provided with an opening through which a molding compound 62 can be injected.

- Please amend the paragraph which begins on page 6, line 26, in the Description of the Preferred Embodiments, as follows:

It must again be emphasized that the advantages that applied to the method that has been shown in cross section in Fig. 2 equally apply to the method shown in cross section on Fig. 4a that is forcing the ~~epoxy~~ mold compound under the flip ~~chip~~ chips 50, 52 and 54 and having a uniform, stress free interface between the flip chip 36 and the ~~heatsink 16~~ heatsink 56.

- Please amend the paragraph which begins on page 6, line 30, in Description of the Preferred Embodiments, as follows:

Fig. 4b shows how the completed ~~package 70~~ package 69 of multiple flip-chips encased in the mold can be separated into separate flip-chip packages. It will be recognized

that the ~~package~~ package 69 that is shown in Fig. 4b is the same package that was transported across the flexible tape 60 in Fig. 4a. A scorching or milling ~~operation 66~~ operation 67 will subdivide the multiple flip-chip package 70 into individual flip-chip packages 70, 72 and 74.

- Please amend the paragraph which begins on page 7, line 3, in the Description of the Preferred Embodiments, as follows:

Fig. 4c shows one of the flip-chip packages that has been created in accordance with the invention. The IC chip 80 ~~with it~~ with its contact balls 86 is in contact with heatsink 82. The contact balls 86 of the IC chip 80 are in contact with the substrate 84 that is provided with contact balls 88. The IC chip 80 is encased in a mold compound 90, the mold compound 90 is also present between the IC chip 80 and the substrate 84 thereby forming the underfill for the IC chip 80.

- Please amend the Abstract which begins on page 13, line 1, as follows with the replacement Abstract which begins on the next page: